

tion of the marker positions in the two-dimensional image can already be carried out with algorithms adapted to this situation. Hereby, the reliability, speed and accuracy of the position calculation for markers which are affected by artifacts increases.

For the data transfer in both directions, i.e. from the image recording to the image processing and reverse, it is advantageous to use physically the same information channel. The information transfer can then be executed by using separate frequency windows or time slots. An information transfer via Ethernet connections is appropriate.

With the invention, a particularly favorable application possibility results for tracking systems which operate with passive markers, i.e. such markers, which reflect electromagnetic rays in the visual or infrared range. In such systems, at least one lighting device, which is allocated to one of the image recording devices, is used for the irradiation of the markers. Retroreflectors as markers have the advantage of reflecting back a major part of the incident light in the direction of incidence.

In most of the applications of optical tracking systems, a large extent of the distance between image recording device (camera) and object (target) must be covered. Consequently, the system must deliver sufficiently accurate results for small distances just as for large distances between camera and target. However, the image recording devices (CCD chips) which are usual for optical tracking system have a dynamic range with upper and lower limit, i.e. a signal below a lower intensity limit of the incident signal can no longer be satisfactorily separated from the background and above an upper intensity limit saturation effects occur. Because of this, the position

determination becomes less accurate. For optical tracking systems with passive (retroreflecting markers) and a non-variable luminous intensity, the extent of the distance to be covered between the camera and the target in many cases of application is so large that in the normal operation the lower limit or the upper limit of the dynamic range is fallen short of or exceeded, respectively.

Two solutions are suggested for this problem, without however solving the problem satisfactorily: Operating with an automatic diaphragm or controlling the luminous intensity similarly to a computer flash. However, both solutions are impractical. For cameras with an automatic diaphragm, the required accuracy of the image correction can no longer be guaranteed. The use of a "computer flash", which adds up the incoming light energy and upon reaching a limit value stops the lighting, will in many cases, because of nonspecific reflexes (mirroring surfaces) or external sources of interference (e.g. spotlights), deliver unusable results. Even a situation which is typical in the practice, for example, the illumination of two targets, out of which one is located near the tracking camera (image recording device) and one far away from it, cannot be satisfactorily mastered with this type of computer flash.

It is possible to solve this problem with the data re-transfer according to the invention. From a computing device (central computing device) the tracking cameras (image recording devices) receive information about the current distance of the markers to the individual image recording devices and about the type of markers. For each individual image recording device, the luminous intensity can then be set to the requirements. Thus, it is ensured that the system operates within the dynamic range of the image recording device.

The information, which luminous intensity is required for which distance and for which type of marker, can be taken from a given look-up table, which is the result of previous laboratory experiments.

Another possibility is to take the luminous intensity required not or not exclusively from a given table, but to adjust it as follows: information about the luminosity of the individual markers is already available in the tracking camera (image recording device) or in the associated computing device (2D-computing stage) connected to its output, as result of the computations regarding a recorded image. It is then possible to readjust the luminous intensity from image to image in such a way that the maximum luminosity (brightest pixel) of the relevant markers remains close to a specified value. This value is, for example, 80% of the maximum modulation. According to the invention, for this purpose, information about the current or expected locations of the relevant markers together with information about the luminosity of these markers is retransferred to the lighting control unit. For this, for example, data about the expected locations of markers is forwarded from the central computing device, whereas information about the luminosity of markers are transferred to the lighting control unit over a shorter path directly from the image recording device or the first (2D) computing stage connected to its output.

In addition to controlling the luminous intensity, the spatial light distribution in the image area of the image recording device also can be controlled. For this purpose, a lighting device with a light emitting zone having a plurality of subdivided segments is used, wherein the individual segments can be accessed separately. The indi-